SOUTH BOSTON WATERFRONT

Balancing Past, Present, & Future

4.433 Modeling Urban Energy Flows

Jamie Bemis, Rachel Belanger, Tianyi Chen, Alex Mercuri

May 3, 2016

DESIGN PHILOSOPHY & GUIDING PRINCIPLES

Design for district-scale efficiency

Create a community that builds on Boston's beloved neigbhorhoods

Design with a changing climate in mind

RESPONDING TO CONFLICTING VALUES:

MORE HOUSING

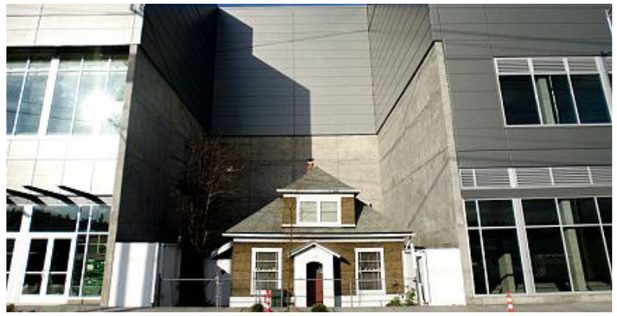
Provide new housing stock to address Boston's regional housing crunch

LESS GHG

Aim to meet Boston's citywide 2020 greenhouse gas emission reduction goals

STAY HISTORIC

Preserve the historic character of South Boston and the "triple-decker" feel

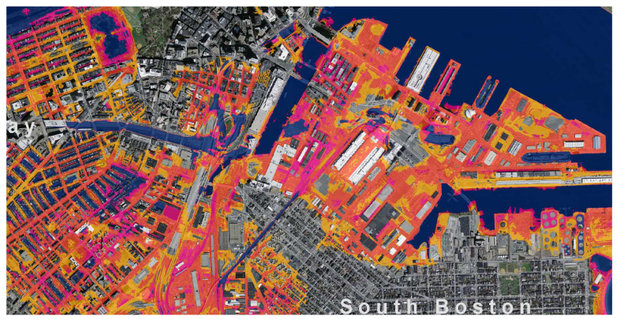


MODERNIZE

Provide new buildings that can meet modern performance standards

DENSIFY

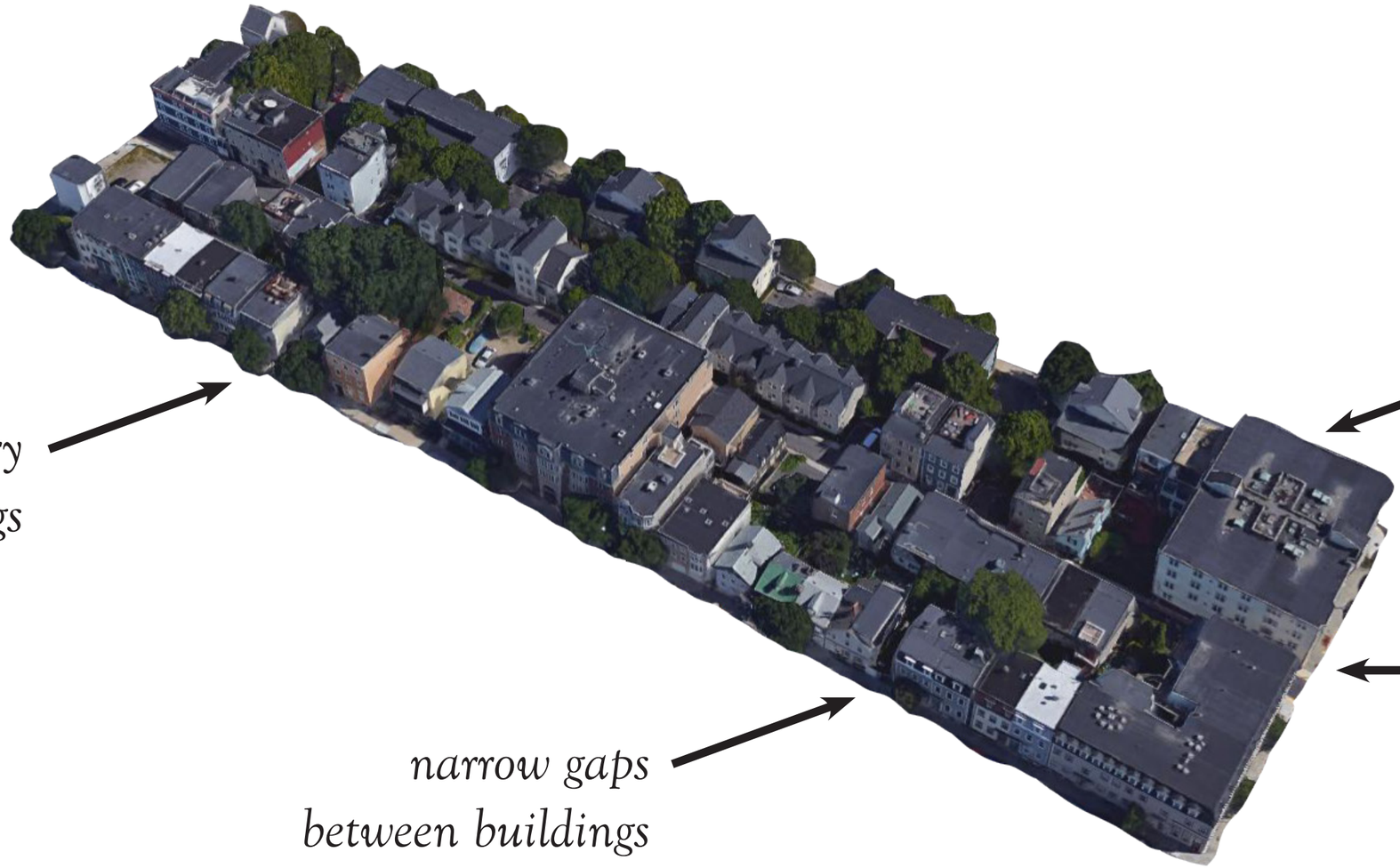
Satisfy environmental, financial, and livability goals with sufficient density



MANAGED RETREAT

Scale back development in flood-prone coastal areas in anticipation of sea level rise

REFERENCE BLOCK: TYPICAL SOUTH BOSTON



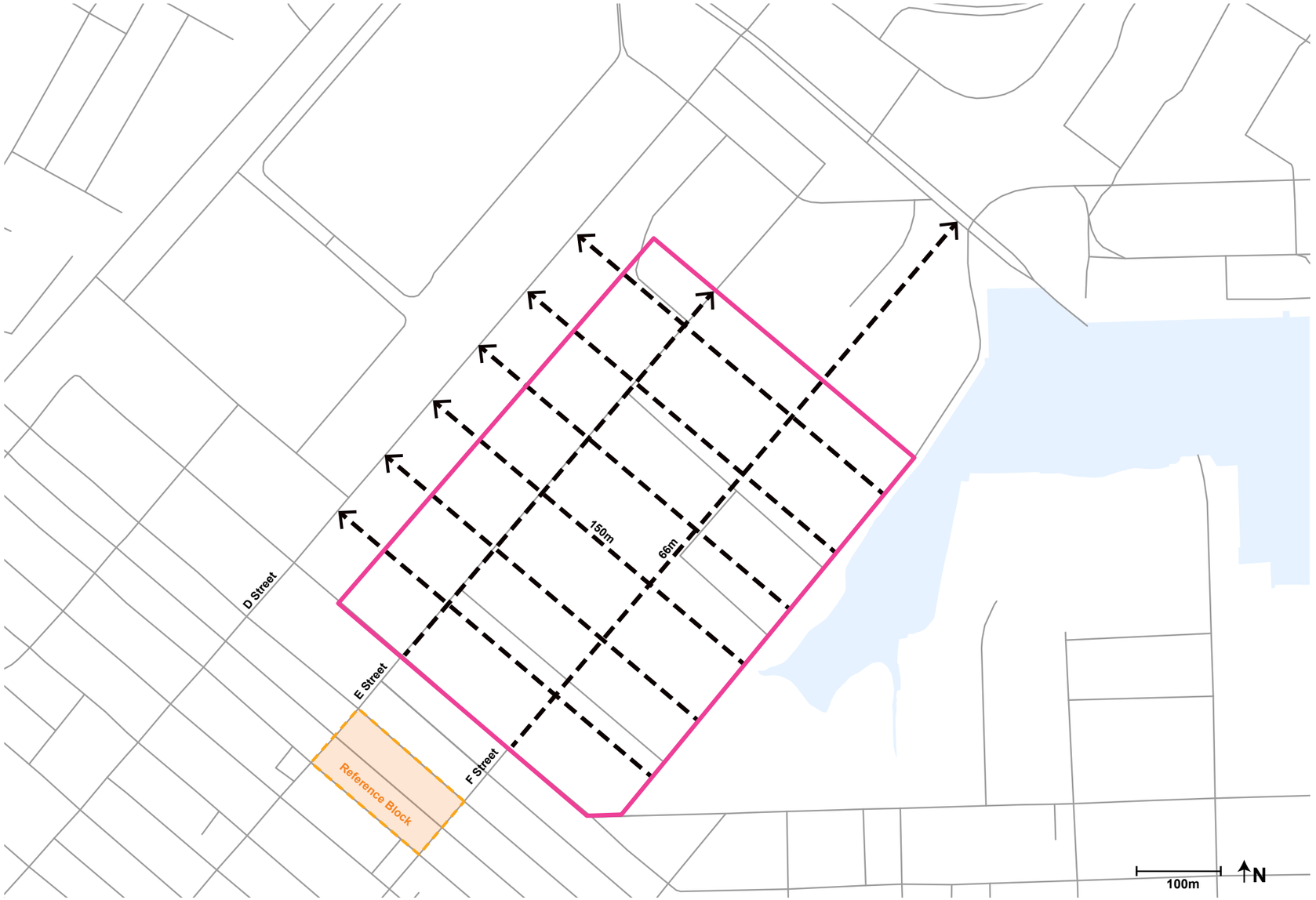
primarily 3-5 story residential buildings

taller buildings located at corners

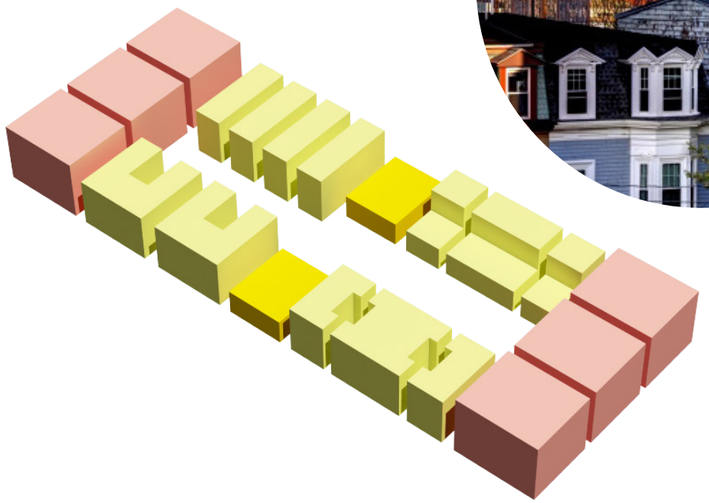
mixed uses on ends of blocks

narrow gaps between buildings

CONNECTING TO THE NEIGHBORHOOD

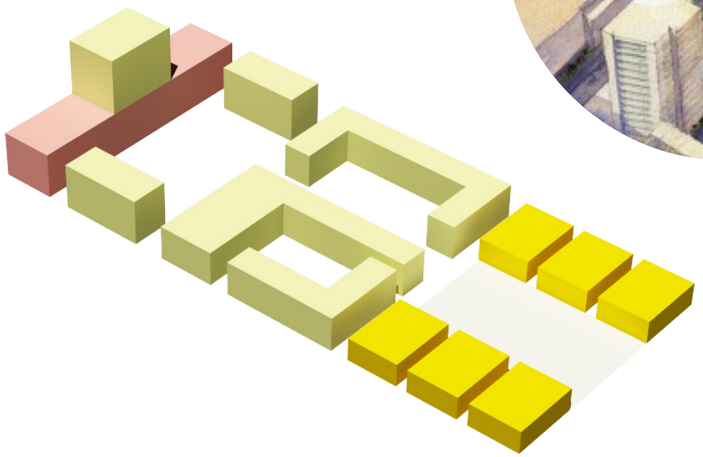


PROTOBLOCK A: HISTORIC BOSTON



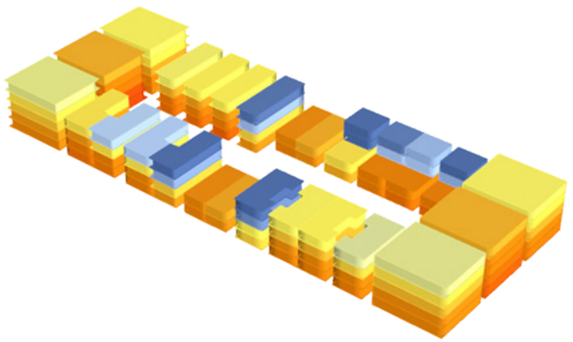
Classic triple-decker feel

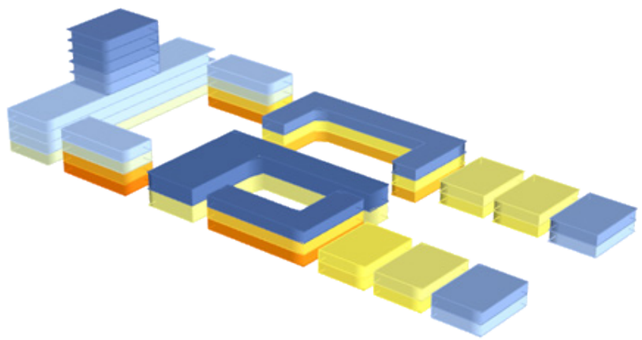
PROTOBLOCK B: NEW SEAPORT

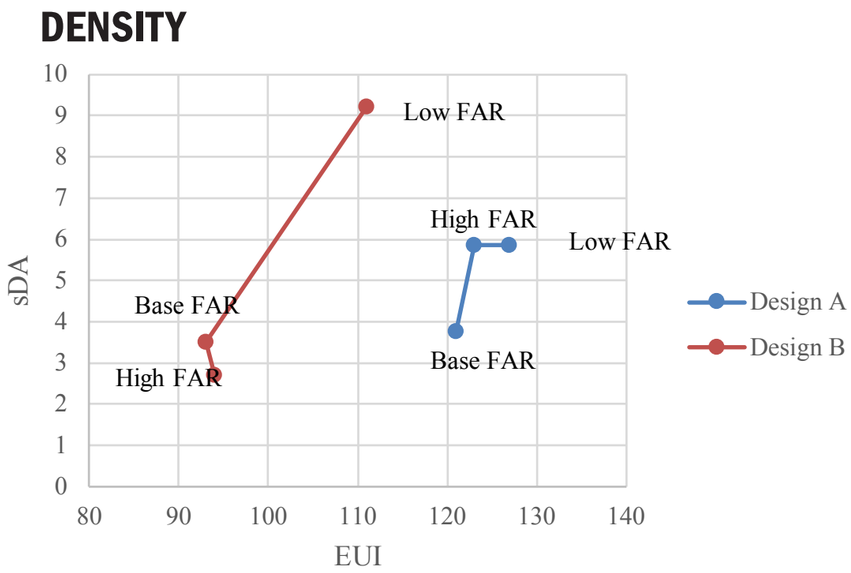


High-density and high value

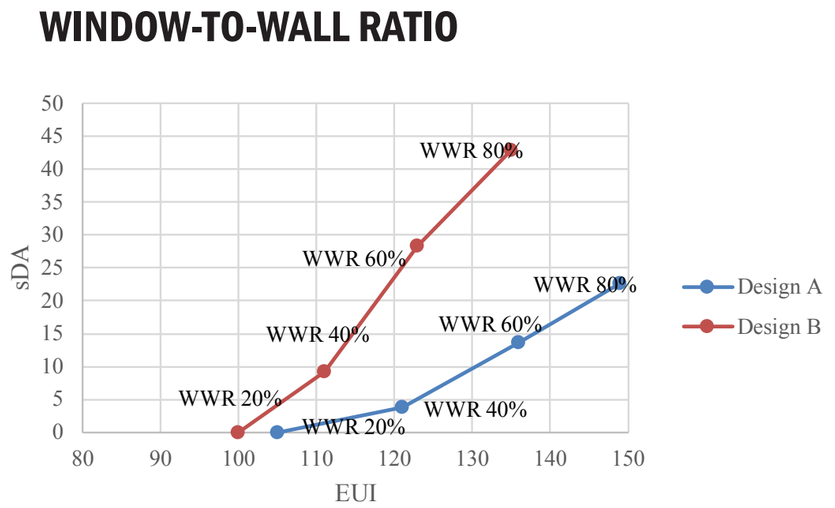
DAYLIGHTING ANALYSIS





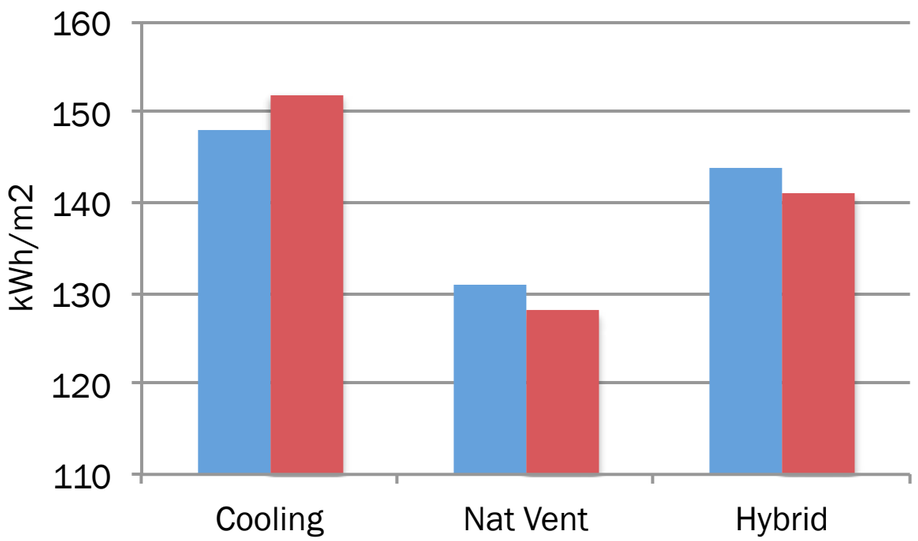


	DESIGN A	DESIGN B
Floor Area Ratio	2.04	1.51
Window-to-Wall Ratio (%)	60	Res 50 (SE 60), Ret & Off 60 (SE 80)
Occupants	767	674
Energy Use Intensity (kWh/m2)	136	122
Energy Use per Occopant (kWh/p)	3540	2526
Global Spatial Daylight Autonomy (%)	13.6	30.5

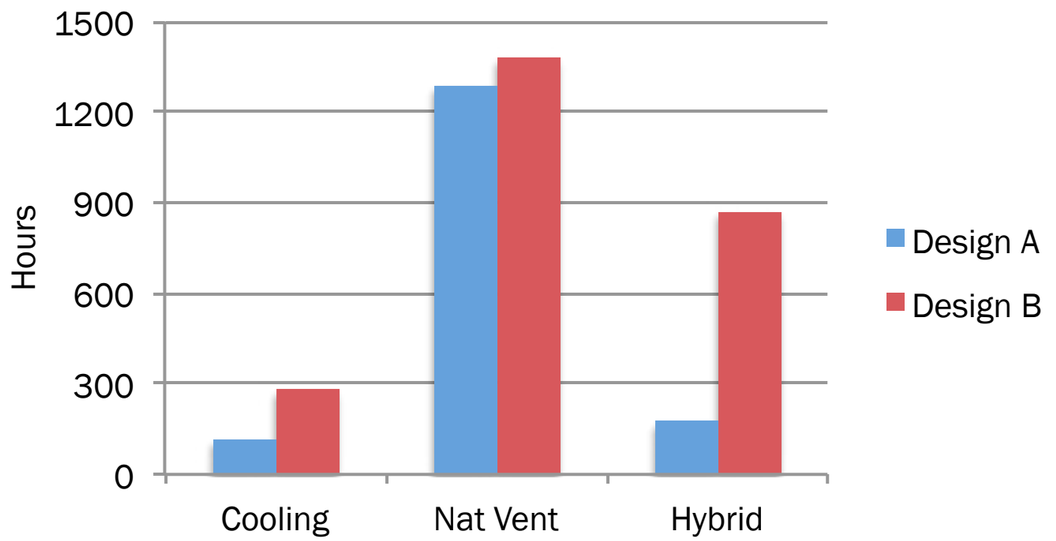


NATURAL VENTILATION POTENTIAL

ENERGY USE INTENSITY

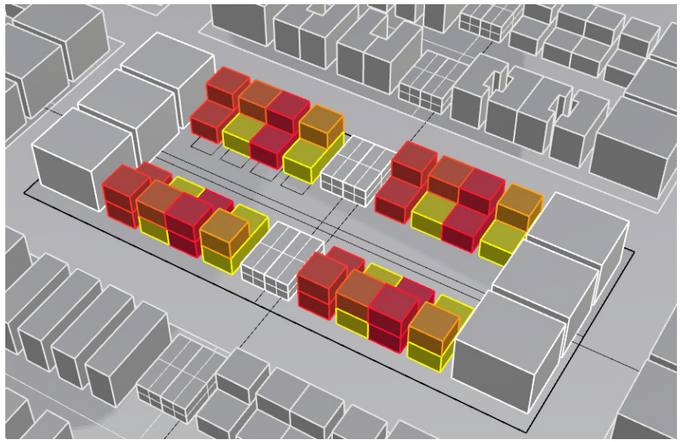


OVERHEATING HOURS

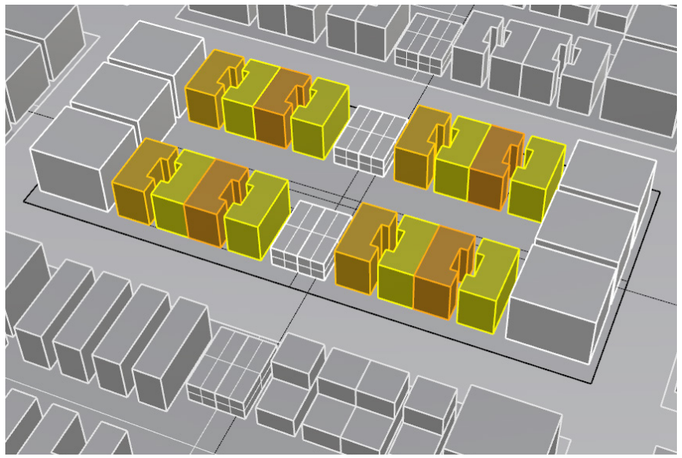


URBAN REGULATIONS

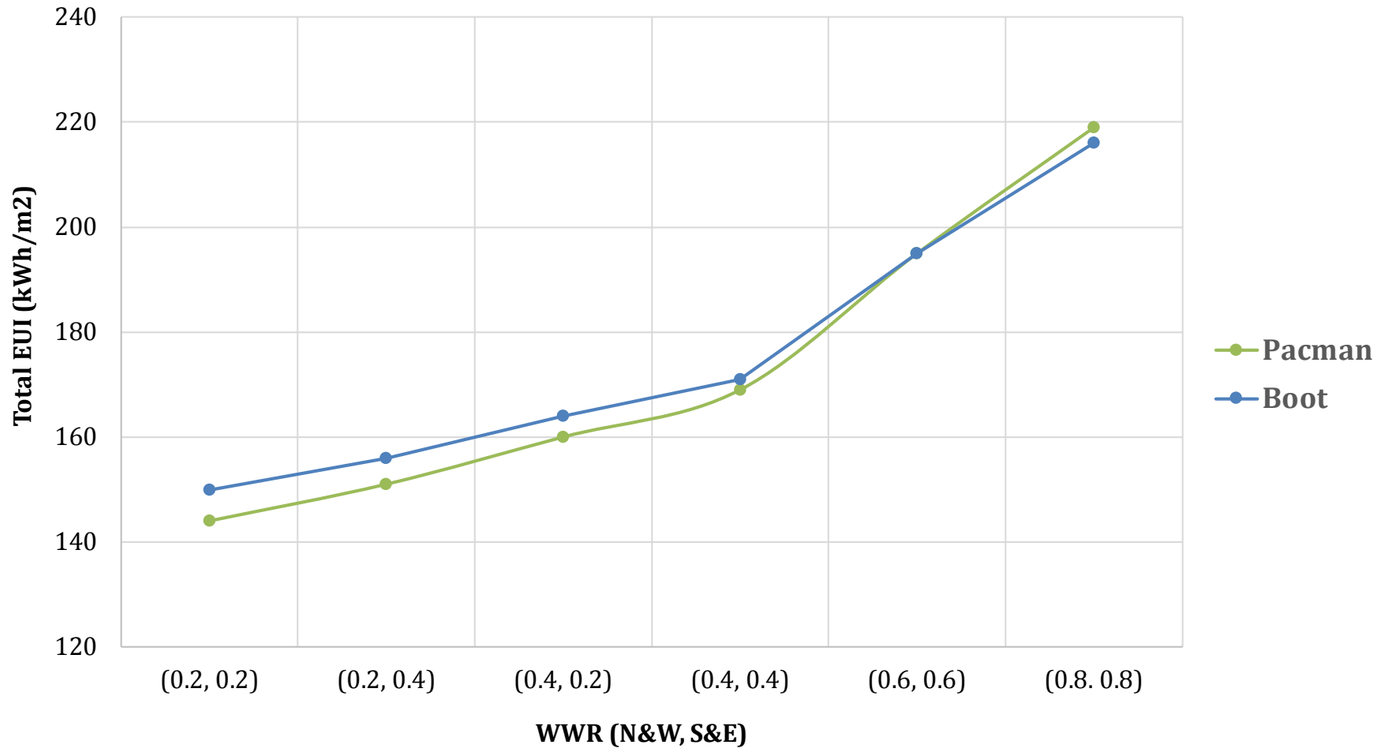
“BOOT” GEOMETRY ANALYSIS



“PAC-MAN” GEOMETRY ANALYSIS

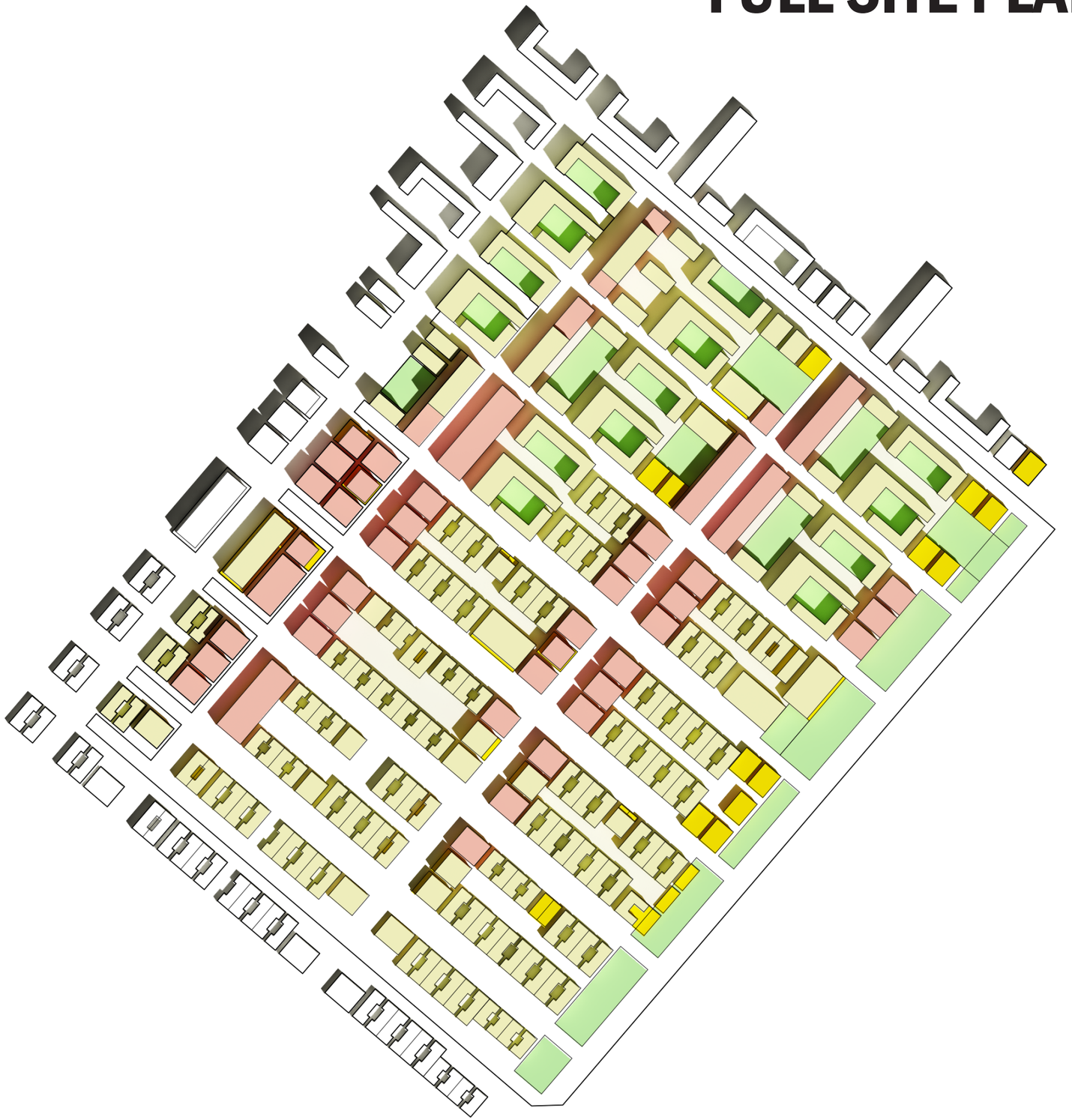


Regulating EUI is our best option for reconciling our neighborhood goals with potential energy efficiency gains



FULL SITE DESIGN IN CONTEXT

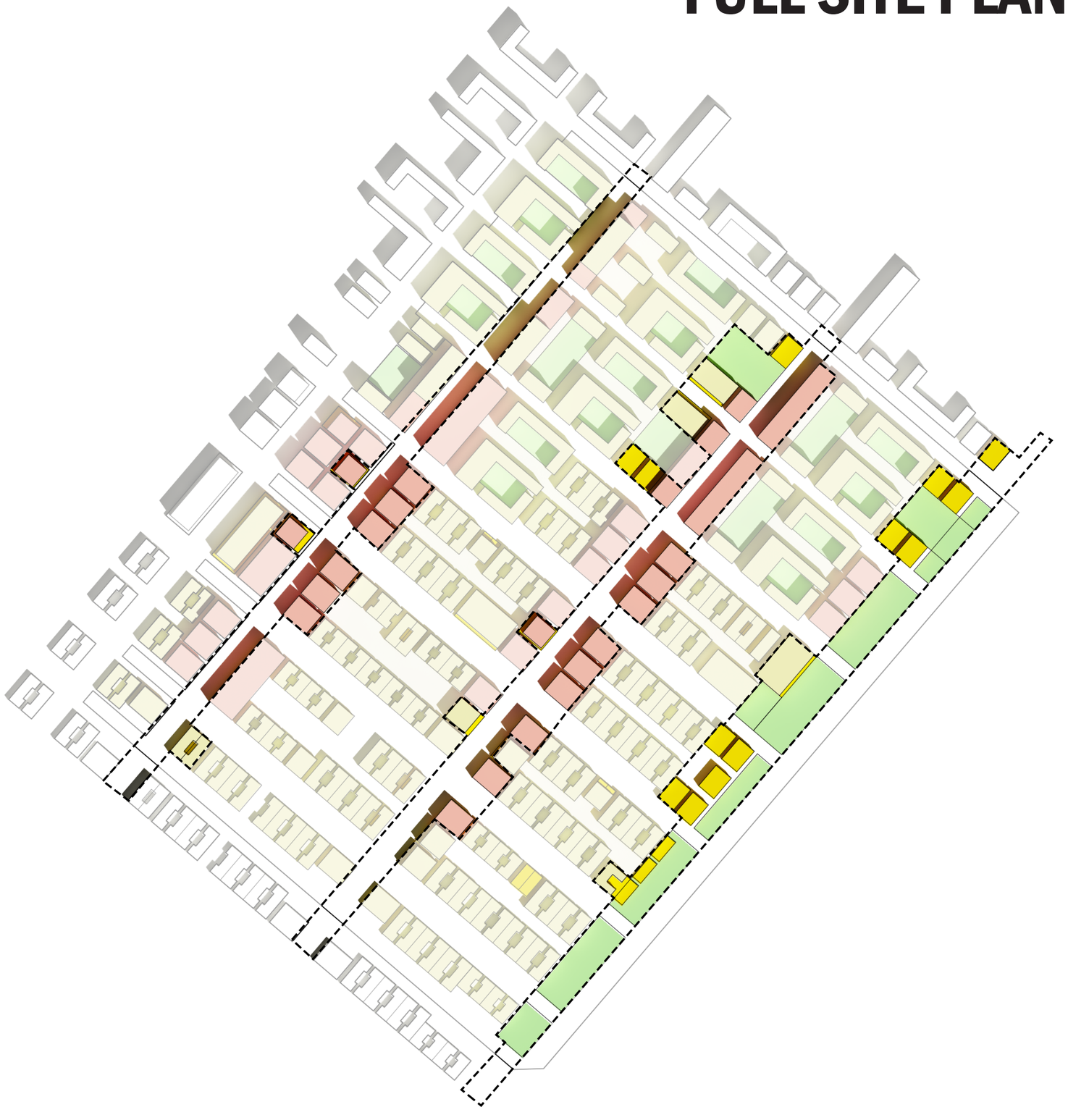
FULL SITE PLAN



SUMMARY

Floor Area Ratio	2
Gross Floor Area (m^2)	335,708
Residential	63%
Office	28%
Retail	9%
Occupants	10,814
Public Park (% of total area)	13%
Max. Building Height	9 floors
Average Building Height (Story)	4 floors

FULL SITE PLAN



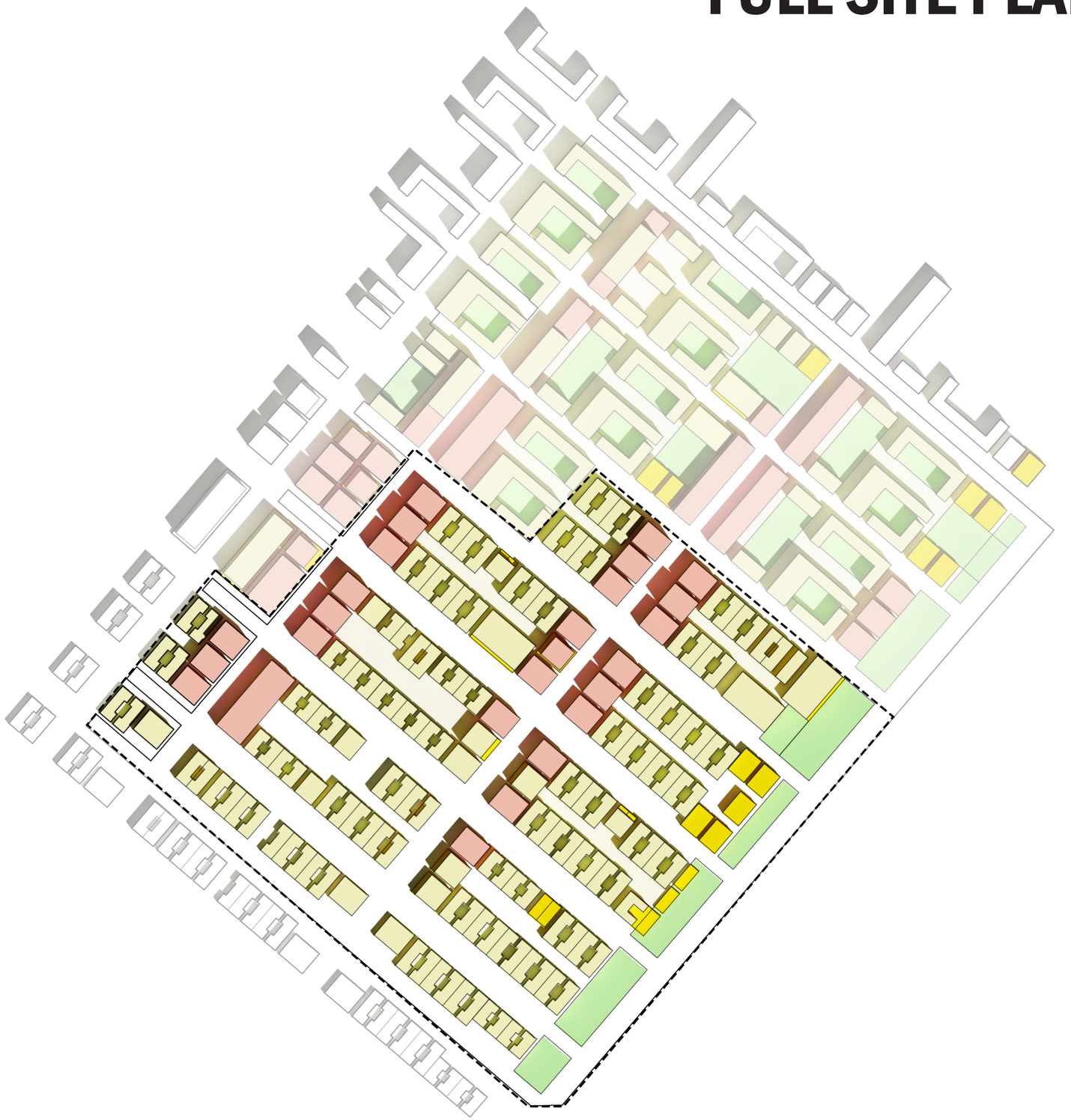
MAIN STREETS

South: Maximum open space and flood mitigation plan

Middle: Mixed-use with walkable design and ample public amenities

North: Mixed-use with higher-density office development

FULL SITE PLAN



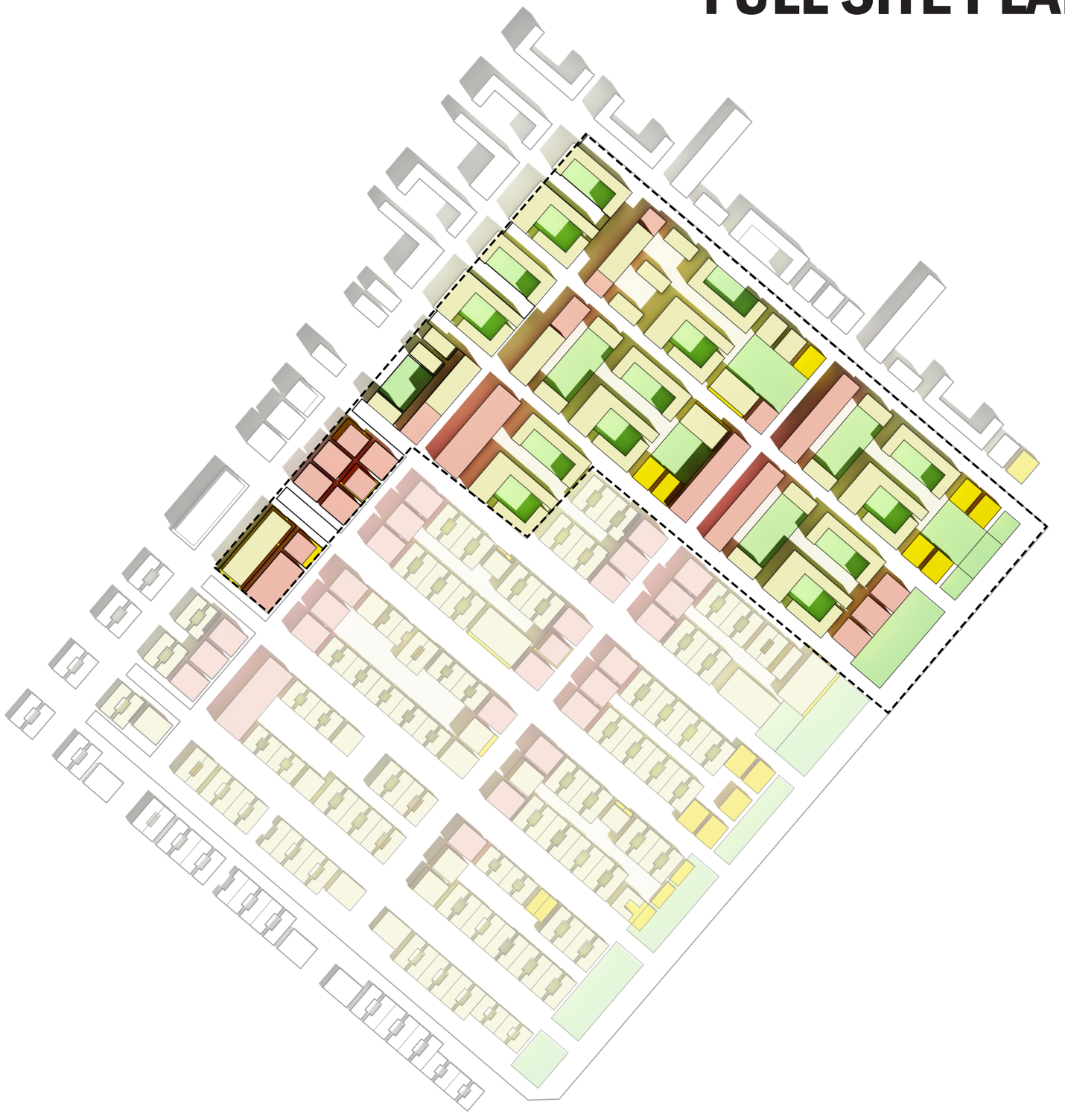
SOUTH SIDE

Inspiration from South Boston residential style

Energy simulation allows for better performance while still evoking historic typologies

Density gradient from low (south) to medium to mediate between two constrasting neighborhood characters

FULL SITE PLAN

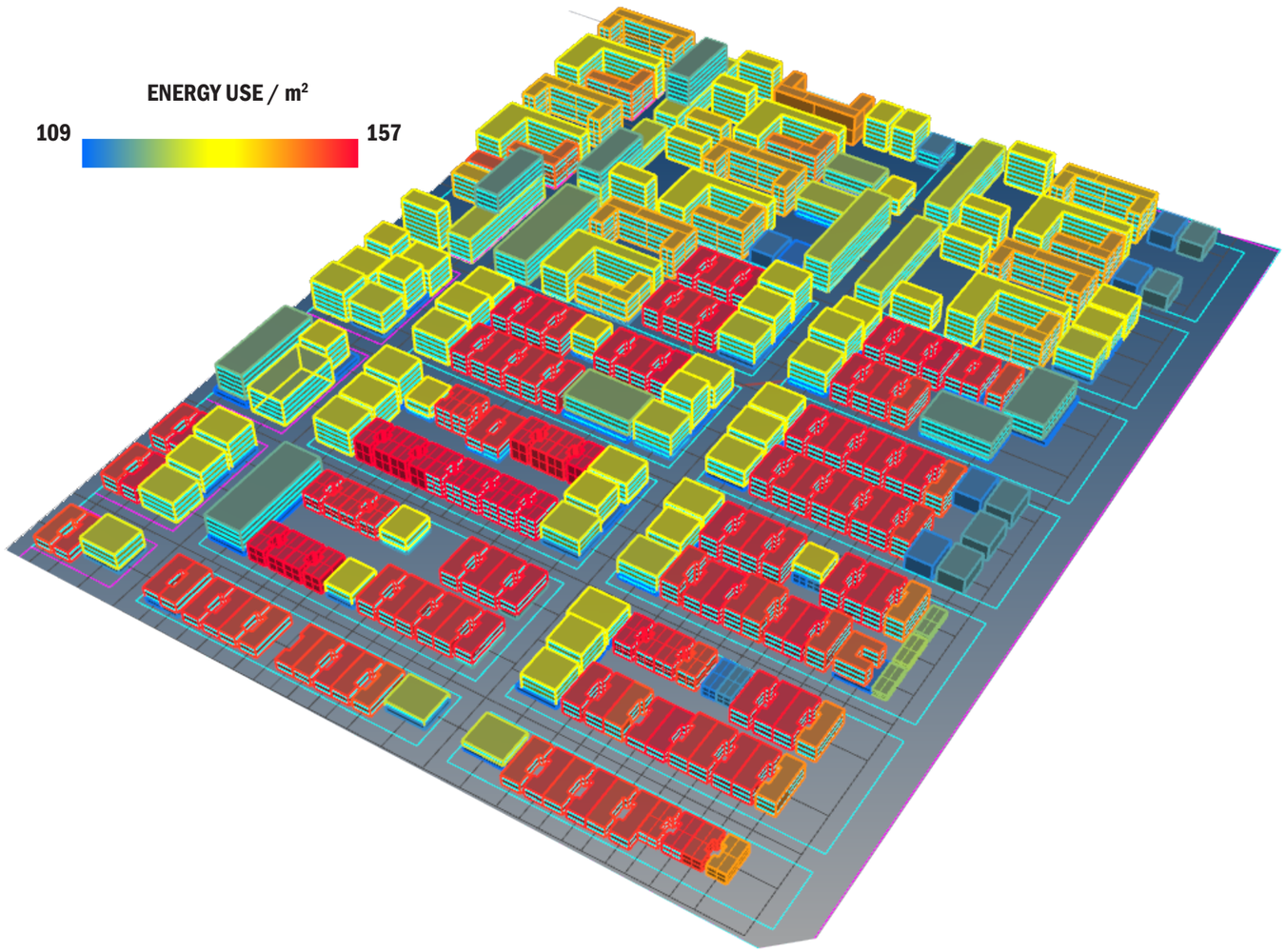


NORTH SIDE

Increased building heights with small block footprints

Stylized to fit with boston waterfront developments to the north

DESIGNING FOR DISTRICT-SCALE EFFICIENCY



Energy use intensity varies significantly between our two block typologies

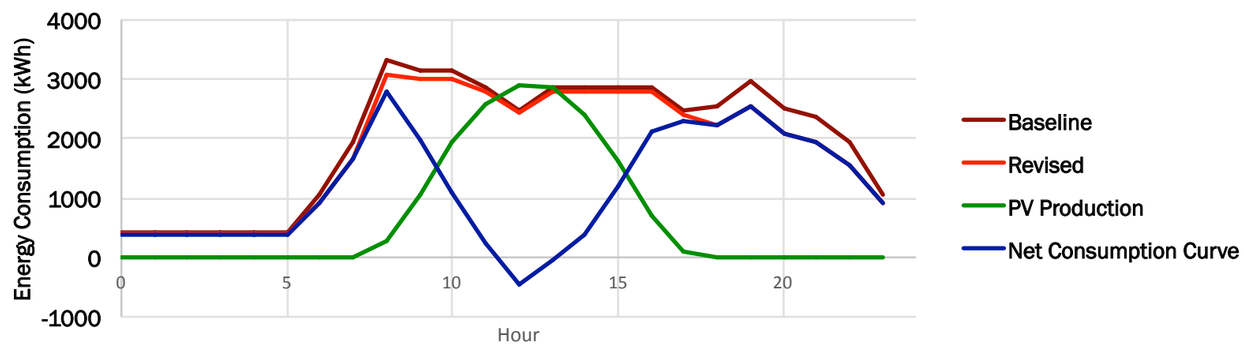
Intuitively important metric for a residential/mixed use neighborhood such as ours

Sacrifice in energy efficiency for historical style and neighborhood quality

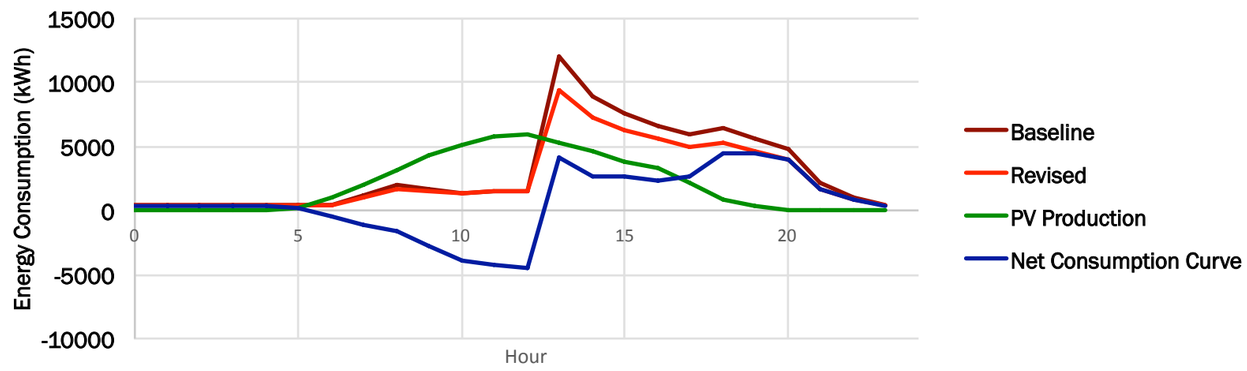
DESIGNING FOR DISTRICT-SCALE EFFICIENCY

	BASELINE	REVISED
Infiltration Rate	0.35	0.35
Attic U-Value		Added more fiberglass insulation
Basement U-Value	Fiberglass batting	XPS Board
Basement Wall U-Value		0.50
Wall U-Value	Fiberglass batting	XPS Board
Total Heating COP	0.9	0.92
Total Cooling COP	3	3.2
Windows (U-values)	Clear	Low E
Equipment	4	3.5
Lighting	7	5
Cooling Setpoint	24	25
Heating Setpoint	20	19.5

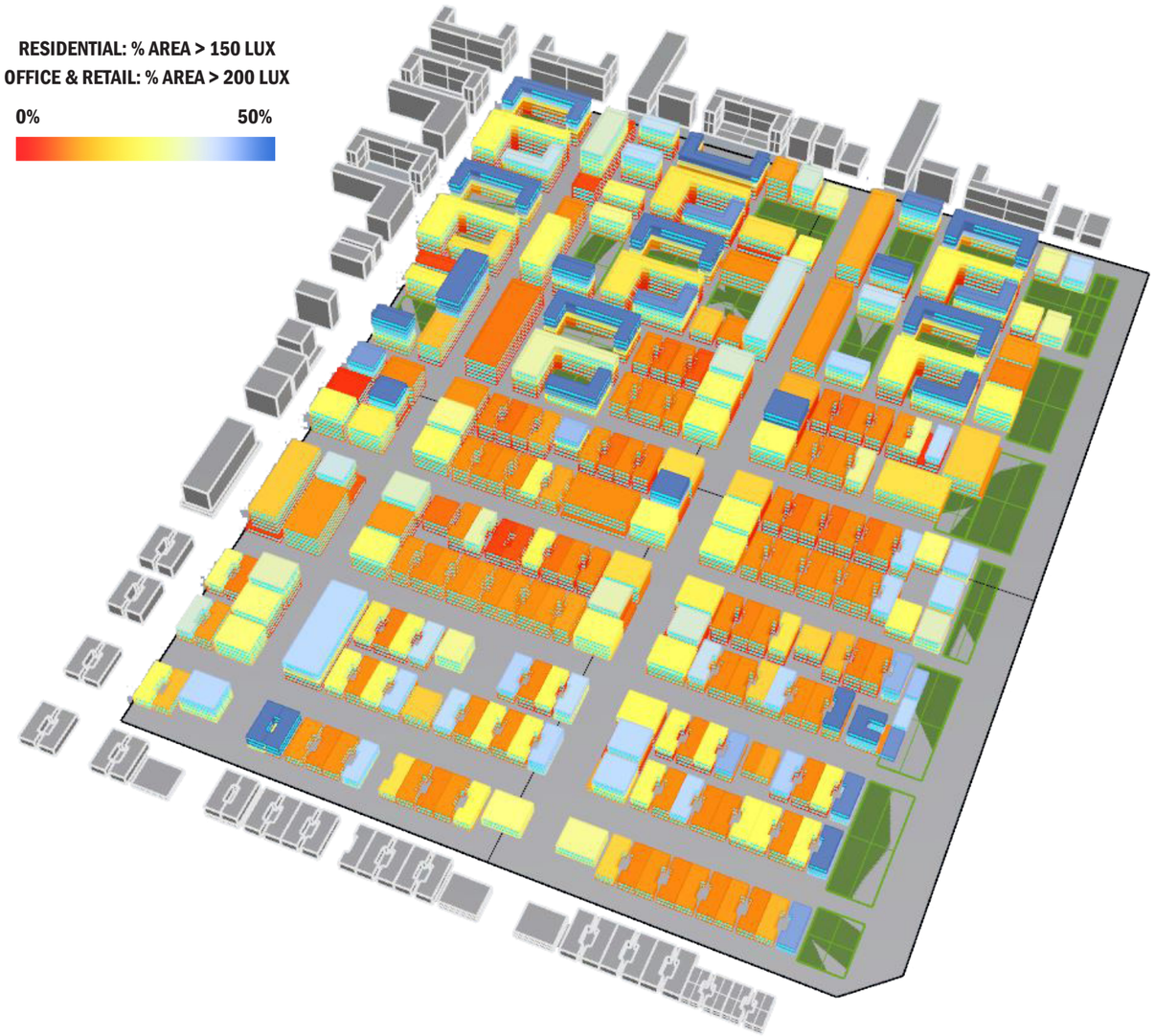
ENERGY CONSUMPTION BY HOUR ON JANUARY 23RD



ENERGY CONSUMPTION BY HOUR ON JULY 9TH



DAYLIGHTING POTENTIAL



A 300 lux threshold doesdn't make sense for our expected neighborhood uses

Daylighting threshold relaxed to 150 lux for residential uses and 200 lux for all other uses

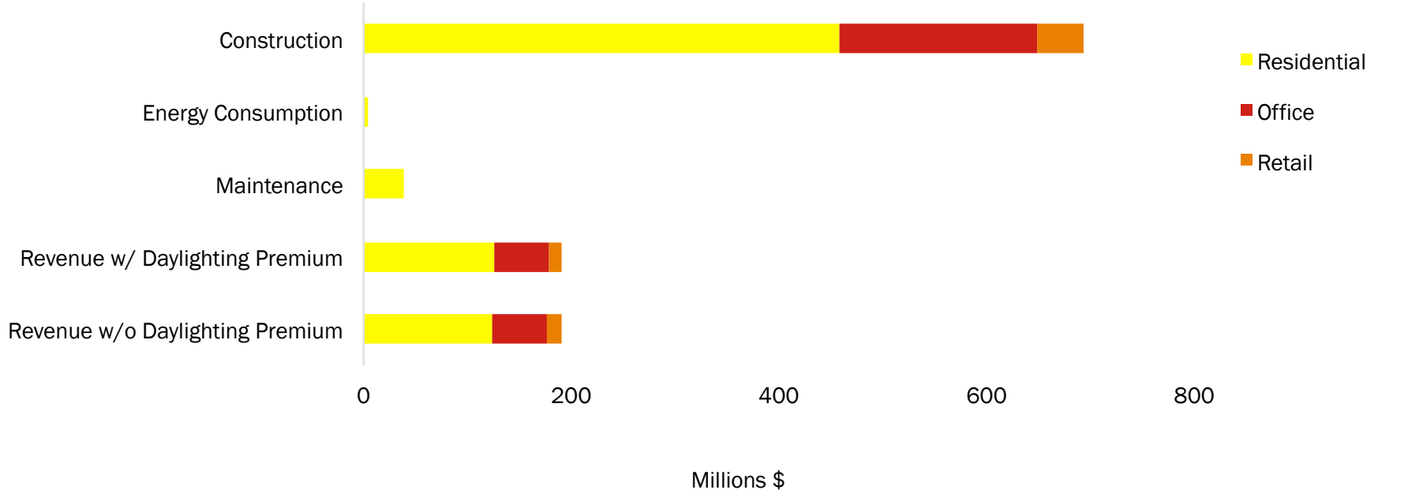
14% of space meets new standards

FINANCIAL PERFORMANCE

INPUTS		
Annual Rent Rates ($/m2/a)	Residential	600
	Official	575
	Retail	450
Daylighting Premium (%)		0.2

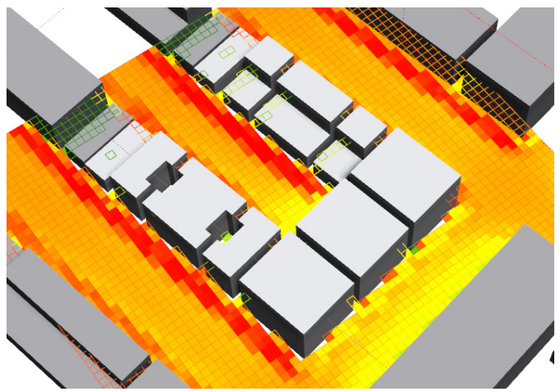
RESULTS	*Baseline*	*with Daylighting Premium*
Cash Flow from Operations	$147,036,491	$148,594,813
CFO/Construction Cost	21.2%	21.4%

COSTS AND ANNUAL INCOME



BUILDING OFF BOSTON'S NEIGHBORHOODS – WALKABILITY

WALKABILITY – OUTDOOR THERMAL COMFORT

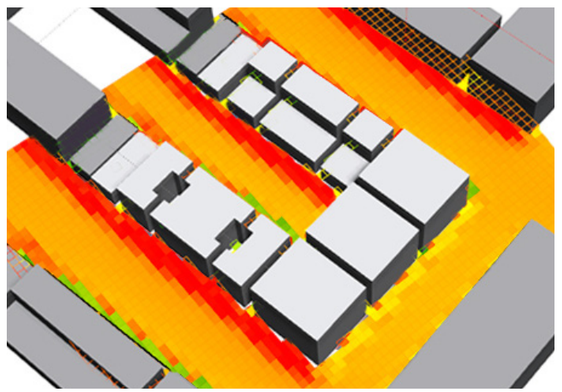


SPRING MORNING:
MAY AT 10:00AM

Urban Thermal Comfort Index:

No thermal stress	*95%*
Moderate heat stress	*5%*

- *The areas of moderate heat stress are close to buildings.*
- *Heat stress appears to correlate with the areas of lower wind speeds.*

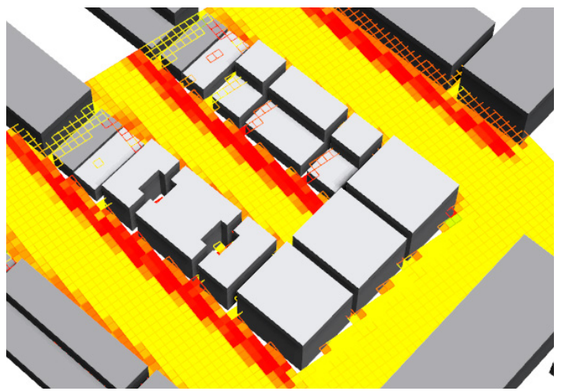


SUMMER LUNCHTIME:
JULY AT 1:00PM

Urban Thermal Comfort Index:

No thermal stress	*15%*
Slight heat stress	*2%*
Moderate heat stress	*31%*
Strong heat stress	*52%*

- *Design should creating shade through street trees, awnings, or overhangs.*
- *Design interventions that reduce wind speeds would not be desirable*



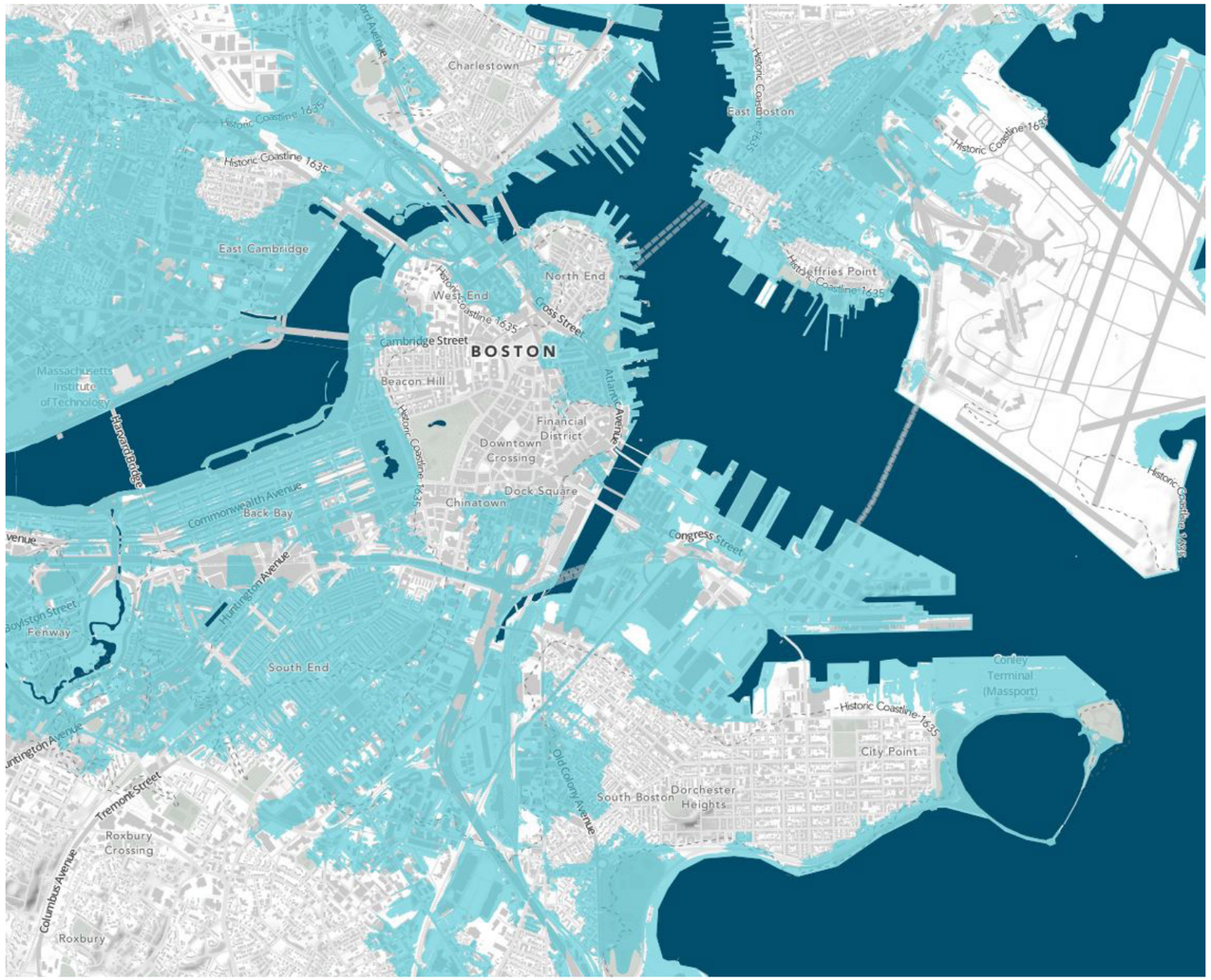
FALL EVENING COMMUTE:
SEPTEMBER AT 5:00PM

Urban Thermal Comfort Index:

No thermal stress	*100%*

DESIGNING FOR A CHANGING CLIMATE

DESIGNING FOR A CHANGING CLIMATE



Potential flooding due to a major storm in 2050, assuming 2 ft of sea level rise and a 5 ft storm surge

Image Credit: Sasaki Associates

RECOMMENDED STRATGIES

- *Critical systems located above first floor*
- *Permeable Streets*
- *Operable Windows*
- *First floor designed to withstand flooding*
- *All occupied floors above BFE*

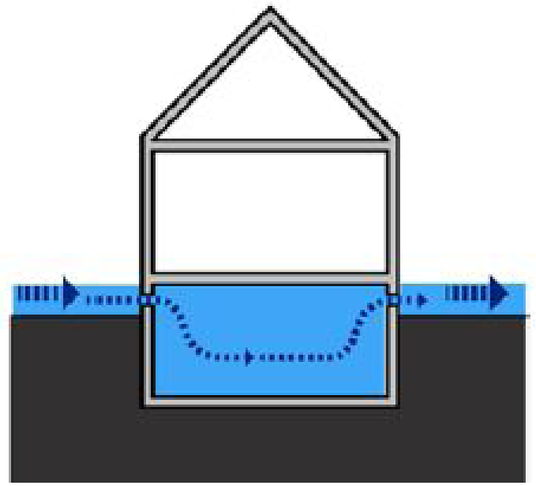


Image Credit: Building Resilience In Boston Report, 2013

SOUTH BOSTON WATERFRONT

Land area (m2)	**220,000**
Building area (m2)	**350,000**
Residents (pp/m2 land)	**0.017**
Workers (pp/m2 land)	**0.016**

135
kWh/m2y
OPERATION ENERGY

2050
kWh/m2
EMBODIED ENERGY (50y)

140
kgCO2/m2
BUILDING GHG EMISSIONS (50y)

4
% DA
DAYLIGHT AREA

85
% WS
WALKABILITY SCORE

21
% ROI
FINANCIAL RETURN (1y)

CONCLUDING THOUGHTS

1. *Design for district-scale efficiency*
   - *Energy-efficient buildings reduce environmental impact*
   - *Rooftop PV can offset peak demands*
   - *Load shifting and demand response should be considered in the future*
   - *Tradeoffs require that certain design parameters are prioritized (EUI vs. sDA)*

2. *Design with a changing climate in mind*
   - *Flood mitigation is a critical aspect of this sites design*
   - *Street trees and permeable surfaces can offset summer heat*

3. *Create a community that builds on Boston's best neighborhoods*
   - *Human scale, walkability, and thoughtful building design were key aspects of our site*